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OCEAN OBSERVER SATELLITE STUDY

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OCEAN OBSERVER USER REQUIREMENTS STUDY

Purpose: To determine the U.S. ocean observation requirements

User Requirements Team: Over 215 scientists from the US academic community, DoD, DOC, DOI, DOT, EPA, FEMA. NASA, NSF, USDA

User Requirements: 55 Environmental Data Requirements (EDRs) specified

EDRs covered oceans, coastal areas, flood areas, soil moisture, vegetation, and other parameters related to the oceans or rivers/lakes.

Each EDR contains minimum requirements (Threshold) and optimum requirements (Objective) for each of a number of characteristics of the parameter being measured (such as range, timeliness and accuracy).

OCEAN OBSERVER ENVIRONMENTAL DATA REQUIREMENTS

2.0 Ocean Requirements

2.1a Global Sea Surface Winds
2.1b Coastal Sea Surface Winds
2.2a Global Sea Surface Wind Stress
2.2b Coastal Sea Surface Wind Stress
2.3a Sea Surface Height
2.3b Sea Surface Height Coastal
2.4a Oean Wave Characteristics - Significant Wave Height
2.4b Ocean Wave Characteristics - Wave Direction/Wavelength
2.5a High Resolution Weather-Impacted Imagery
2.5b Low Resolution All-Weather Imagery
2.5c High Resolution All Weather Imagery
2.5d Coastal Imagery
2.6 Oil Spill Location
2.7 Vessel Positions
2.8 Bathymetry (Deep Ocean and Near Shore)
2.9a Ocean Color
2.9b Coastal Ocean Color
2.10a Chlorophyll
2.10b Coastal Chlorophyll
2.11a Ocean Optical Properties
2.11b Coastal Ocean Optical Properties
2.12 Bioluminescence Potential
2.14a Sea Surface Temperature
2.14b Low Resolution All Weather SST
2.14c Sea Surface Temperature Imagery
2.14d Coastal Sea Surface Temperature
2.15 Net Heat Flux
2.16a Open Ocean Currents
2.16b Surface Currents
2.16c Littoral Currents
2.17 Salinity
2.18 Surf Conditions
2.19 Mesoscale Ocean Features

3.0 Cryospheric Requirements

3.1 Ice Concentration/Age/Motion/Edge Location
3.2 Ice of Land Origin (Icebergs)
3.3 Ice Surface Temperature
3.4 Sea Ice Freeboard
3.5 River Ice Location/Condition
3.6 Glacier Volumetric Change
3.7 Continental Ice Sheet Melt Zone
3.8 Ice-Sheet Motion
3.9 Ice-Sheet Grounding Line Position
3.10 Sea Ice Characterization

4.0 Hydrologic Requirements

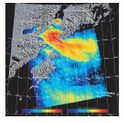
4.1 Flood Mapping
4.2 Snow Water Equivalent Mapping
4.3a Soil Moisture (Surface)
4.3b Regional Soil Moisture
4.4 Coastal Wetland Mapping

5.0 Land Requirements

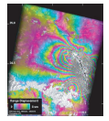
5.1 Land Surface Topography
5.2 Land Surface Deformation
5.3 Land Surface Freeze/Thaw State
5.4 Vegetation Classification/Biomass
5.5 Coastal Change

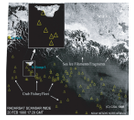
6.0 Atmospheric Requirements

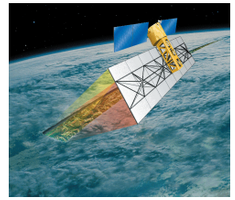
6.1 Mesoscale Atmospheric Features
6.2 Microscale Atmospheric Features


Coastal Winds


Coastal Imagery (Visible)


Land Surface Deformation


Sea Ice



C & L BAND INTERFEROMETRIC SAR with VIS/IR IMAGING SPECTROMETER

VISIBLE/INFRARED IMAGING SPECTROMETER (Coastal Ocean Imager)

- 100 m resolution
  - 150 km swath
  - Can tilt to follow coastline
  - 64 10 nm spectral channels from 380 to 1000 nm
  - 2 infrared window channels (10.8 and 12 micrometers)
  - Primarily for coastal ocean color and sea surface temperature

C & L BAND INTERFEROMETRIC SAR

- Dual frequency, multiple polarization, multimode
- Along track interferometry for ocean currents
- Repeat pass interferometry for land deformation
- Cross track interferometry using two satellites during part of mission (2.5 years overlap after 5 years and 10 years into mission)

Mode of Operation	Fine Mode	Dual Polarization	Standard Mode	ScanSAR Narrow a	ScanSAR Narrow b	ScanSAR Wide a	ScanSAR Wide b
Resolution (m)	ai 5 si 10	25	25	50	100	100	100
Ground Swath (km)	ai 25 si 34	100	100	300	300	600	600
Number of Looks	ai 2 si 3	2	4	4.7	4.7	10.20	10.20
Polarization	HH or VV	HH & HV or VV & VH or HH & VH or VV & HH	HH or VV	HH & VV	HH or VV	HH & VV	HH or VV

SAR C-BAND MODES

Mode of Operation	Fine Mode	Quad Polarization	Dual Polarization	Standard Mode	Split Spectrum Ionospheric Correction	Scan SAR Narrow a	Scan SAR Narrow b	Scan SAR Wide
Resolution (m)	10	25	25	25	25	50	50	100
Ground Swath (km)	30	50	100	100	100	350	350	600
Number of Looks	3	2	3	4	4	4	4	8
Polarization	HH	HH, HV, VV, VH	HH & HV or VV & VH or HH & VV	HH or VV	HH or VV	HH & VV	HH or VV	HH or VV

SAR L-BAND MODES

OCEAN OBSERVER STUDY OBJECTIVES

1) Determine what ocean and hazard remote sensing observations are needed operationally

2) Translate the needs into requirements

3) Examine instrument and satellite options to meet the requirements

4) Determine costs for building the operational satellite system

OCEAN OBSERVER SUMMARY

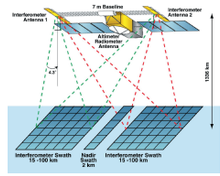
Ocean Observer would supplement NPOESS Program with needed but unmet operational observations.

Ocean Observer is currently unfunded.

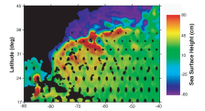
Ocean Observer would obtain:

- Ocean Topography Measurements
- Surface Current Measurements
- Various Coastal Measurements
- Marine Biological Measurements
- Flood Measurements
- Soil Moisture Measurements
- Land Deformation Measurements
- Vegetation Measurements

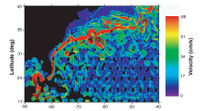
Mission would be for 15 years using 3 pairs of satellites.



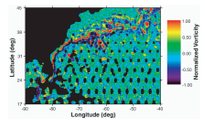
COASTAL WIDE-SWATH ALTIMETER



Sea Surface Height



Velocity



Normalized Vorticity

ENVIRONMENTAL DATA REQUIREMENT (EDR) EXAMPLE

2.3a ***Sea Surface Height*** (DOC/DOD/Academia/DOT) - Sea surface height is the topography of the ocean surface with respect to the Earth's reference ellipsoid defined in a well-maintained terrestrial reference frame. Its variability is associated with mesoscale, basin scale, and global scale (DOC only) ocean phenomena. Coastal sea level variability is required for estimation of tidal sea level variations and tidal current variations. The requirements below apply under both clear and cloudy conditions.

OOS Sea Surface Height EDR(DOC/DOD/Academia/DOT)

Systems Capabilities	*Threshold*	*Objective*
a. Horizontal Resolution		
1. Satellite Nadir Resolution		
a. Coastal Scale	2 km	100 m
b. Mesoscale	15 km	2 km
c. Basin Scale	15 km	2 km
d. Global Scale	15 km	2 km
2. Horizontal Reporting Interval		
b. Mesoscale	1 km	0.2 km
3. Closest Point to Shore		
b. Mesoscale	20 km	3 km
b. Measurement Precision	3 cm	2 cm
c. Measurement Accuracy		
b. Mesoscale	6 cm	4 cm
d. Sampling Repeat Period (may be different from satellite repeat period)		
b. Mesoscale	10 - 35 day	1 day
e. Equatorial Track Spacing		
b. Mesoscale	< 165 km	15 km
f. Timeliness		
b. Mesoscale	24 hours	3 hours
g. Geographic Coverage		
b. Mesoscale	66 S to 66 N	85 S to 85 N
h. Long Term Stability (after calibration)		
b. Mesoscale	1 cm/yr	1 cm/yr

Explanation/Justification (Sea Surface Height DOC/DOD/Academia/DOT):

(B) Mesoscale Ocean.
(DOC) Mesoscale sea surface height is associated with eddies and western boundary currents having length scales up to a few hundred km and time scales of days to weeks. Examples off the US coast are the Gulf Stream, the Loop Current in the Gulf of Mexico, rings/eddies formed by these currents, and eddies of the California Current system. NOAA programs such as NCEP's Coastal Ocean Forecast System presently assimilate a variety of ocean data, including sea surface height from satellites. The National Hurricane Center also takes advantage of sea surface height data to help in the estimation and forecast of hurricane intensity. For applications such as these, timeliness is critical, with observations required with no more than a 24-hour delay. Absolute accuracy of the sea surface height measurement (i.e, radial orbit determination) is less important because the data can be high-pass filtered to reveal the mesoscale features of interest. This requirement, derived from NOAA's goal of advancing short-term warning and forecasts services, is described in the publications: "National Ocean Partnership project advances real-time coastal ocean forecasting", EOS Trans. AGU, 81 (14), 145-150, 2000, "Controls on hurricane intensity", Nature, 40, 665-669, 1999, and "Towards an operational nowcast/forecast system for the U.S. East Coast", Modern Approaches to Data Assimilation in Ocean Modeling, Elsevier Oceanography Series, 61, 347-376, 1996.

(DOD) Mesoscale sea surface height variations associated with eddies and current meanders are the major contributors to ocean temperature changes. The thermocline shifts correlated to the surface pressure changes dramatically alter the ocean environment within which the Navy must operate. In addition, the mesoscale field is a large contributor to the ocean currents. Because the mesoscale field is chaotic, not directly related to the wind field, and thus not predictable far in advance, continuous observations of the mesoscale field are required to monitor the environment that may impact Navy acoustic operations for Anti Submarine Warfare (ASW) and prediction of mine drift trajectories. Operational systems are presently in place within the Naval Oceanographic Office to exploit available altimeter data streams. The operational systems provide daily observations to numerical model systems that in turn feed information to the Navy fleet. Timeliness is essential for these operational products. In line with the DOC requirements, radial orbit accuracy is of secondary concern for the mesoscale products. The majority of the orbit solution errors are removed through post processing at the Navy operational centers. The Navy mesoscale requirements are outlined in the document "Navy Altimeter Data

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